Common Polyatomic Ions and the Corresponding Acids

There is a pattern associated with many of the polyatomic ions in chemistry that can aid you when learning names and the relationships with the corresponding acids. Some combinations of a central atom with oxygen are found more often in nature, and they are designated the "common" form of the polyatomic... yet due to oxygen's "social nature", several other combinations of the central atom with oxygen can exist. A pattern exists which relates the number of oxygen atoms relative to the "common" form... and this pattern can be extended to a host of oxygen-containing acids.

First, remember this phrase:

"**Nick** the **Camel Brat** ate **Icky Clam** for **Supper** in **Phoenix**"

This phrase helps you remember the **central atom**, the **number of oxygen atoms in the "common" form** of the polyatomic, and the **charge** on the polyatomic ion. ***All of the common form polyatomic ions get an "ate" suffix.***

- The **number of consonants** = the **number of oxygen atoms** in the common form of the polyatomic ion
- The **number of vowels** = the **negative charge** on the polyatomic ion

Nick = **nitr**ate, NO_3^{-1}
Camel = **carb**onate, CO_3^{-2}
Brat = **brom**ate, BrO_3^{-1}
Icky = **iod**ate, IO_3^{-1} *(note that **y** is a consonant and not a vowel in this context!)*
Clam = **chlor**ate, ClO_3^{-1}
Supper = **sulf**ate, SO_4^{-2}
Phoenix = **phosph**ate, PO_4^{-3}

- Polyatomic ions in the **common** form have an "**ate**" suffix (i.e. chlor**ate**, ClO_3^{-1})
- Polyatomic ions with **one more oxygen** than the common form get a "**per**" prefix and an "**ate**" suffix (i.e. **per**chlor**ate**, ClO_4^{-1})
- Polyatomic ions with **one less oxygen** than the common form get an "**ite**" ending (i.e. chlor**ite**, ClO_2^{-1})
- Polyatomic ions with **two less oxygen atoms** than the common form get a "**hypo**" prefix and the "**ite**" suffix (i.e. **hypo**chlor**ite**, ClO^{-1})

The following table shows the various polyatomic ions and all of their known variations:

	nitrogen	*carbon*	*bromine*	*iodine*	*chlorine*	*sulfur*	*phosphorus*
-2 oxygen	-	-	**hypo**brom**ite**, BrO^{-1}	**hypo**iod**ite**, IO^{-1}	**hypo**chlor**ite**, ClO^{-1}	-	-
-1 oxygen	nitr**ite**, NO_2^{-1}	-	brom**ite**, BrO_2^{-1}	iod**ite**, IO_2^{-1}	chlor**ite**, ClO_2^{-1}	sulf**ite**, SO_3^{-2}	phosph**ite**, PO_3^{-3}
common	nitr**ate**, NO_3^{-1}	carbon**ate**, CO_3^{-2}	brom**ate**, BrO_3^{-1}	iod**ate**, IO_3^{-1}	chlor**ate**, ClO_3^{-1}	sulf**ate**, SO_4^{-2}	phosph**ate**, PO_4^{-3}
+1 oxygen	-	-	**per**brom**ate**, BrO_4^{-1}	**per**iod**ate**, IO_4^{-1}	**per**chlor**ate**, ClO_4^{-1}	-	-

Entries with a "-" are not known to exist and can be ignored.

Polyatomic ions readily make acids. An acid is a compound with a hydrogen atom that reacts readily with other substances. In chemistry, we list the acidic hydrogen first to designate its reactivity.

As before, a naming pattern exists for acids containing an oxygenated polyatomic ion:

- Acidic polyatomic ions in the **common** form have an "**ic acid**" suffix (i.e. chlor**ic acid**, $HClO_3$)
- Acidic polyatomic ions with **one more oxygen** than the common form get a "**per**" prefix and an "**ic acid**" suffix (i.e. **per**chlor**ic acid**, $HClO_4$)
- Acidic polyatomic ions with **one less oxygen** than the common form get an "**ous acid**" ending (i.e. chlor**ous acid**, $HClO_2$)
- Acidic polyatomic ions with **two less oxygen atoms** than the common form get a "**hypo**" prefix and the "**ous acid**" suffix (i.e. **hypo**chlor**ous acid**, HClO)
- Acidic polyatomic ions with **no oxygen atoms** get a "**hydro**" prefix and the "**ic acid**" suffix (i.e. **hydro**chlor**ic acid**, HCl)

The following table shows the acidic form of the polyatomic ions with all of their known variations:

	nitrogen	*carbon*	*bromine*	*iodine*	*chlorine*	*sulfur*	*phosphorus*
no oxygen	-	-	**hydro**brom**ic acid**, HBr	**hydro**iod**ic acid**, HI	**hydro**chlor**ic acid**, HCl	**hydro**sulfur**ic acid**, H_2S	-
-2 oxygen	-	-	**hypo**brom**ous acid**, HBrO	**hypo**iod**ous acid**, HIO	**hypo**chlor**ous acid**, HClO	-	-
-1 oxygen	nitr**ous acid**, HNO_2	-	brom**ous acid**, $HBrO_2$	iod**ous acid**, HIO_2	chlor**ous acid**, $HClO_2$	sulfur**ous acid**, H_2SO_3	phosphor**ous acid**, H_3PO_3
common	nitr**ic acid**, HNO_3	carbon**ic acid**, H_2CO_3	brom**ic acid**, $HBrO_3$	iod**ic acid**, HIO_3	chlor**ic acid**, $HClO_3$	sulfur**ic acid**, H_2SO_4	phosphor**ic acid**, H_3PO_4
+1 oxygen	-	-	**per**brom**ic acid**, $HBrO_4$	**per**iod**ic acid**, HIO_4	**per**chlor**ic acid**, $HClO_4$	-	-

Finally, please note that this list is not 100% inclusive... but similar patterns can be applied to polyatomic ions not on this list. For example,

- H_2SeO_4 = selenic acid *and* H_2SeO_3 = selenous acid
- AsO_4^{-3} = arsenate ion *and* AsO_3^{-3} = arsenite ion

And if you cannot get enough polyatomic ions… here's another useful phrase:

"**Simon** and **Bonnie Aspired** to **Search** the **Creepy Count** for the **Icky Clam**"

Simon = SiO_3^{2-} = silicate
Bonnie = BO_3^{3-} = borate
Aspired = AsO_4^{2-} = arsenate
Search = SeO_4^{2-} = selenate
Creepy = CrO_4^{2-} = chromate
Count = CO_3^{2-} = carbonate
Icky = IO_3^{1-} = silicate
Clam = ClO_3^{1-} = chlorate